In the Matter of	)	
	)	
Consumer Information and Disclosure	)	CG Docket No. 09-158
	)	
Truth-in-Billing and Billing Format	)	CC Docket No. 98-170
	)	
IP-Enabled Services	)	WC Docket No. 04-36

<u>COMMENTS OF ROOT WIRELESS, INC. – DA 10-988</u>

<u>SUMMARY</u>

In assessing mobile broadband networks, ultimately what is most important is the performance that actually is experienced by the end users of that network. This experience is a function of not just the network, but of all of the elements that affect delivery of wireless service to that consumer.

The point at which the end user's experience can best be observed is the mobile device used by that person to access broadband service, which typically is their smartphone. The smartphone also contains the technology that makes it possible to collect objective data reflecting the end user's broadband experience. With the use of an easily downloadable application, smartphones by the thousands can be crowdsourced to become network monitoring devices, thus providing a cost-efficient means of gathering comprehensive amounts of data about network performance *as actually experienced*.

A variety of metrics, such as signal strength, data throughput speeds, network failures, and a host of others, can be gathered in this manner to reflect network performance and coverage. The end user's experience can and does vary over time and location due to many

factors, and the level of granularity in the information that is collected can be matched to the degree of specificity sought with respect to such variations.

Crowdsourced data also can be supplemented with information that is gathered through more traditional means, such as drive-testing. By specifying areas and times at which information is to be collected, drive-testing can be a useful means of, for example, measuring network performance in a remote location or over regular intervals at precisely the same spot.

Particularly in light of the ready availability of information regarding mobile broadband network performance and coverage, Root Wireless, Inc. encourages the Commission to undertake a measurement program that will provide the Commission with the comprehensive, analytical findings that can inform its future decision-making.

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I.   Introduction

Root Wireless, Inc. ("Root Wireless" or "Root") respectfully submits these comments in response to the Public Notice released on June 1, 2010, *Comment Sought on Measurement of Mobile Broadband Network Performance and Coverage*, DA 10-988 (the "Notice").

As the Commission has recognized in the National Broadband Plan and elsewhere, mobile broadband networks fill an integral and critical role in the delivery of broadband services. Even though network performance and coverage are among the leading bases upon which mobile wireless carriers compete with each other, to date there has been virtually no objective, quantitative data available from independent third parties to assist consumers and others in assessing these networks. That is about to change.

Root Wireless is the developer of proprietary technology that collects and analyzes wireless network performance as experienced by the end user and displays the results in a variety of formats, including consumer-friendly maps. The company's products include Root Mobile™, a network drive-testing and crowdsourcing application that enables smartphones to serve as network monitoring devices measuring the quality and reliability of wireless voice and data services.

II.   Overview of Measurement Principles

In addressing the questions posed in the Notice regarding whether and how mobile wireless networks should be measured, as well as the more detailed questions that follow, Root Wireless begins from two premises.

First, the ultimate goal should be to measure the service that is being delivered to and experienced by the end user. Mobile broadband networks do not exist in a vacuum; the consumer's experience also is affected by a host of factors outside the network. Among these

are the type of device used, environmental factors (such as seasonal changes in vegetation), proximity to structures and other obstructions, network congestion, the particular generation of network technology in use (for example, a single carrier might operate multiple data networks using CDMA/1XRTT/EV-DO or GPRS/UMTS/HSPA), and usage variations that often follow daily, weekly, and annual patterns or are impacted by special events. A comprehensive study of wireless network performance should be capable of considering most if not all of these variables to assess the actual user experience.

Second, the scope of any attempt to gather measurements on a national scale – both in terms of the area to be covered and the number of measurement variables that should be addressed – make it critical to use crowdsourced data collection methods. At the same time, the data should be gathered in a manner that relies on the crowd to serve as the conduit, but not the filter, for the data. While crowdsourced data may be supplemented with more traditional sampling methods, such as dedicated drive-testing, only crowdsourcing can provide the depth and breadth of information from which comprehensive results can be drawn.

III. What to Measure

One of the consequences of focusing on crowdsourced data about the user's experience is that data should be collected at the point of the device, so the measurement software should reside on the device. Today's smartphones facilitate exactly that approach. In fact, the technology used in smartphones can access many more metrics than may be relevant to measurement of mobile broadband network performance and coverage. Those metrics that Root Wireless considers most relevant are the following:

(1)   Location – Utilizing GPS and/or other location technologies, latitude and longitude coordinates can be recorded with a high degree of accuracy.

(2)	Time and date.

(3)	Signal strength – Measured in decibels.

(4)	No access – Locations where no or insufficient signal is available.

(5)	Dropped call – Locations where calls or data sessions are dropped.

(6)	Data speed – Upload and download.

(7)	Latency – Multiple measures exist.

(8)	Network noise/network congestion – e.g., E_C/I_O, E_C/N_O.

(9)	Packet loss.

(10)	Type of device, firmware, operating system, and browser.

(11)	Battery status.

(12)	Network band.

(13)	Carrier ID.

(14)	Network type.

(15)	Serving network – If the measurement device is configured to permit roaming, measurements should indicate whether the user is being served by the network to which that user subscribes (the home network) or by the network operated by another carrier (a roaming network).

(16)	User movement – Whether the user is in motion or stationary can have a dramatic effect on performance metrics. Being able to serve a user while in motion is a prerequisite of a *mobile* broadband network, so being able to determine whether the measurement device is stationary or in motion is very important.

(17)	Server location.

Under ideal circumstances, these metrics could be collected using all available types of smartphones operating on all carriers' networks. As a practical matter, that level of data collection is unlikely to be available across all platforms. Different devices, due to their design and the way in which the device manufacturers allow them to be used, enable different metrics to be measured. Within these limitations, the handset agent to be used in the measurement program must be able to address a meaningful share of the market, in terms of both networks and devices (and, as a corollary to the latter, operating systems).

IV.   The Critical Role of Devices

When considering mobile broadband networks, the focus is on devices that are capable of being transported easily <u>and</u> of being used while in motion. Therefore, while any device that can be provisioned with an appropriate radio, as might be found in a laptop or even a desktop computer, is capable of using such a network, the devices that are most prominently associated with these are smartphones. As the gateway through which a consumer utilizes a mobile broadband network, smartphones perform an indispensable function.
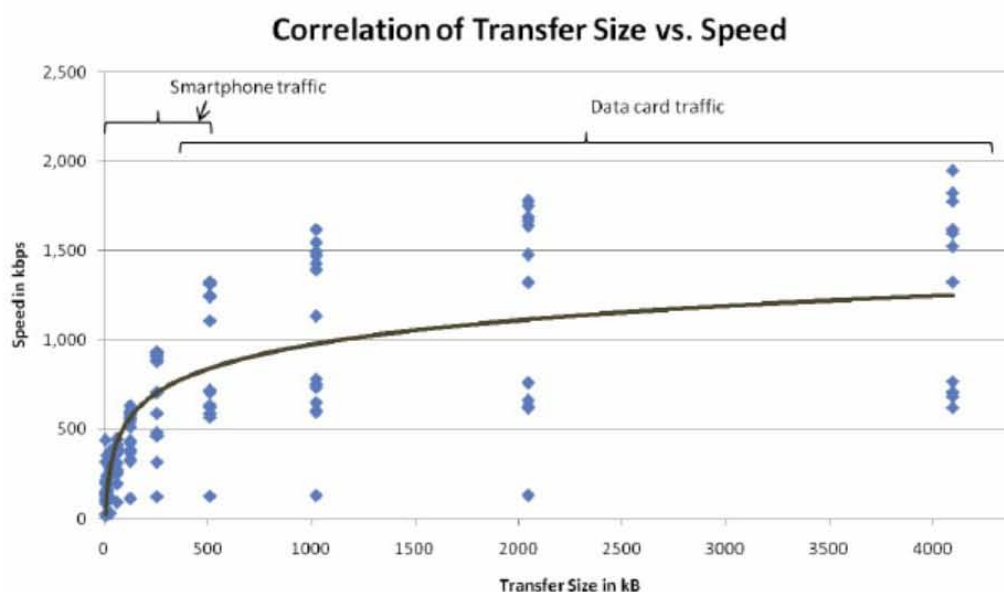
A.   Smartphones

In addition to being one of the, if not the, most popular means to obtain mobile broadband service, smartphones also can serve as the mechanism with which these same networks can be measured using crowdsourced tools. Differences in performance between different types of devices can be addressed by controlling the mix of devices used in the surveys or by using the test results to determine the actual performance difference and applying the appropriate correction factor.

Smartphones, then, are ideally positioned to serve as the means by which the consumer's experience on mobile broadband networks can be measured. Therefore, it is critical that

smartphone manufacturers permit these devices to be used for used this purpose and, in particular, that the handset agent be able to utilize the APIs in the device software that permit access to not only the metrics listed above but also to the full range of network and device performance metrics that will enable consumers to make informed decisions regarding the means by which they will obtain wireless broadband service.

B. Other Devices

Nor will utilizing smartphones as the best available tools to gather data regarding network performance deprive the Commission of information regarding performance experienced through other types of devices. To the extent there are performance differences between types of devices (and we note as an aside that such differences are diminishing as the processing power and capabilities in smartphones approach that of other portable devices), it often relates to the fact that the device design, operating system, and applications written for platforms other than smartphones are more likely to use larger size data packets. The following chart depicts Root Wireless's findings regarding the relationship between packet size and data throughput rates:

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Knowing this relationship, the results measured with smartphones can be used reliably to extrapolate the performance that would be expected with devices other than smartphones when operating on mobile wireless networks.

V.   How to Measure

A.   Data Collection Methods

Crowdsourcing. As discussed above, Root Wireless submits that crowdsourcing provides the optimal means of collecting, in a cost-efficient manner, sufficient data to address the multitude of factors affecting wireless network performance.

As hopefully is evident from the description of how Root Mobile operates, we are not proposing the use of crowdsourced data that depends on active intervention by the end users or on surveys of their perceptions, attitudes, and behavior. Instead, this crowdsourced data is gathered through an automatic and continual duty cycle. Therefore, it provides the thoroughness, randomness, and independence required to provide a statistically sound basis for accurate, fact-based performance reports. While it may be useful to also collect the results of crowdsourced, user-invoked tests, those reviewing the tests must have the ability to view and analyze those results separately in order to assure that their inclusion in the overall test results does not inappropriately skew the data.

Testing in this manner provides a cost-effective means of gathering the huge amount of data required for a study of this nature. For example, this opportunity this can be contrasted with some of the steps currently used by the wireless carriers to monitor their own networks. The two largest carriers in the United States, Verizon Wireless and AT&T Mobility, both report that they test-drive roughly one million miles each year. *See* news.vzw.com/testdriver/index.html *and* www.att.com/gen/press-room?pid=14153. Although it isn't clear from these reports whether this

is the only source of test-drive data used by these companies, Verizon goes on to state that these tests generate "3.5 million voice call attempts and more than 19 million data tests…" By comparison, a test panel of 10,000 participants (such as that being used in the FCC's fixed residential broadband survey that currently is underway) using a passive monitoring system would have to average just over sixty transmissions per day – receiving or sending an e-mail, viewing a web page, sending a photo, and the like – by each participant to generate the same number of data tests in just one month.

Users also can be given the ability to initiate a test or, in a manner similar to that offered through multiple services such as AT&T's "Mark the Spot" application, to send reports about particular network issues. Such reports can be analyzed separately to confirm the validity of this input.

Relying on members of the public to assist in data collection certainly would raise legitimate issues that generally fall within the category of privacy concerns. Root Wireless is very sensitive to these issues and believes that appropriate means exist to address all of them. Participants should be fully informed regarding the manner in which testing will be conducted, how the data that is collected will be used, how other personally identifiable information (if any) will be used, the measures that will be taken to secure all information, and similar considerations. Participants would need to provide their consent in a manner consistent with both legal standards and industry best practices. Appropriate measures should be required to safeguard the information that is collected. Depending on the options that a participant chooses, information could be kept largely or entirely anonymously. Such measures are common and well-understood these days, so there is no reason that these issues should preclude a testing program.

In order to make its crowdsourcing technology acceptable to consumers at large, Root Wireless has focused on reducing the impact to those consumers. Since the application is "always on" in the background on a device, one of the biggest challenges is to minimize the draw on device batteries. Although it is difficult to generalize about battery usage levels because of wide variations in consumer behavior that affect the power requirements, by focusing on this issue at an early stage Root Wireless has been able to manage the level of battery usage to a point that it is not viewed as burdensome by users. Until recently, almost all smartphone users have been on unlimited data plans, so the amount of data transmitted has not been an issue. The introduction of passive testing capabilities in handset agents should satisfy any concerns that consumers may have on this score as tiered pricing plans become more prevalent.

While consumers must register for the service, which includes their opportunity to review Root's terms of use and privacy policy, most consumers are familiar with that process and willing to engage in it for the opportunity to contribute to the development of a pool of information from which they and others can benefit, as well as to gain the ability to view personalized maps of the service they are receiving. This seems to be consistent with the Commission's own experience in offering speed tests and enlisting volunteers for fixed residential broadband testing, each of which has drawn thousands of users.

Other Sources of Data. The traditional method of capturing performance and coverage measurements of mobile wireless networks is through drive-testing. Nothing about crowdsourcing data precludes the use of drive-testing or other methods as a supplemental source of data collection. For example, drive-testing can be used to collect data in sparsely populated areas or in areas where, due to the randomness on which crowdsourcing relies, data may happen

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to be thin. In fact, Root Mobile can be configured for use in this fashion, in which case the frequency with which measurements are taken is dramatically increased.

If crowdsourced and drive-testing data are to be combined or compared, we note the importance of ensuring that the results are comparable. Based on our experience, it should not be assumed that drive-testing will yield higher performance standards. Although traditional drive-testing uses dedicated instrumentation that has been specifically calibrated for the task at hand, it also may be based on older versions of wireless technology than is found in the latest smartphones. Therefore, it is difficult to predict how the two sets of results would compare.

Comparison with Fixed Broadband Measurement Processes. Root Wireless does not claim expertise in the measurement of fixed broadband networks, so we won't presume to offer a detailed comparison of measurement processes. However, we do know that the networks are different in fundamental respects, which leads to the conclusion that what works for one network type doesn't necessarily work for the other. We will cite just two examples of those differences.

We have already discussed the critical role that devices play in measuring mobile networks. By comparison, our understanding of the methodology being used in the Commission's study of fixed residential broadband service is that the measurement hardware is located on the network side of the consumer's broadband modem. Whether the consumer's network access device is part of the measurement system certainly is a potentially significant difference between the two types of networks.

Second, measuring *mobile* networks implies that measurements should reflect performance delivered to users who are moving. The performance experienced on exactly the same device is likely to differ significantly depending on whether that device is in motion or

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stationary. What's more, even at the same location and with all other conditions being the same, the direction in which an end user is moving can affect the performance they experience.

In light of considerations such as these, while the measurement methods used for fixed broadband services provide a worthwhile reference point in considering mobile networks, the standards for the two should not be assumed to be the same.

B.   Other Measurement Considerations

Granularity. As is recognized by the questions in the Notice, network performance is very location- and time-specific. Many of the factors that contribute to the variations over time and location are referred to in Section II above. As just one example of variation over time, the following chart reflects data download speeds on the networks of the four largest carriers as measured at a fixed location near the Las Vegas Convention Center during the two days leading up to and the two days of the Consumer Electronics Show in January 2010:
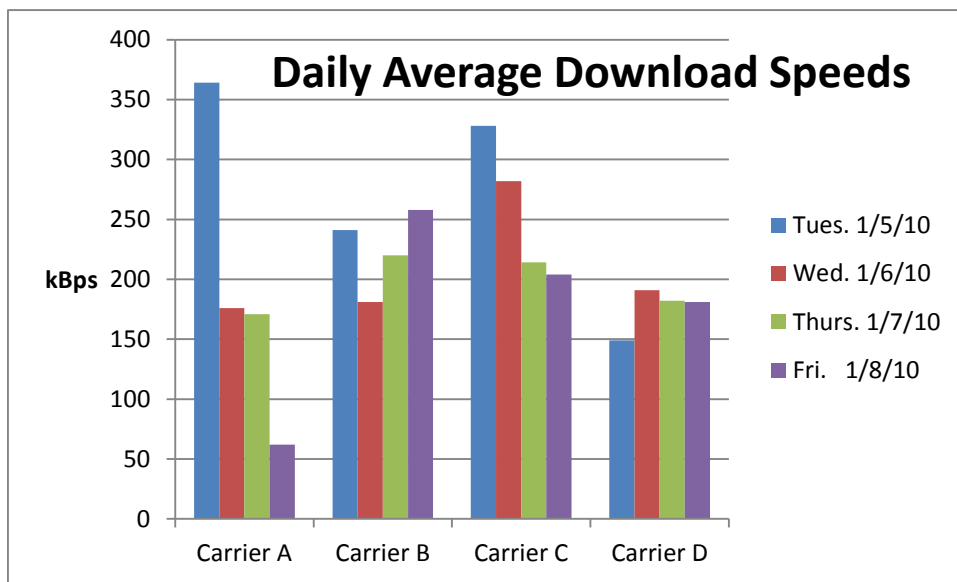
There are many potential explanations for the fluctuation or lack thereof that is evident from this graph. Most importantly, data such as that depicted in this graph provides interested parties –

consumers, carriers, regulators, everyone – an objective starting point from which questions can be asked and judgments ultimately drawn.

It is difficult to say what the *right* level of temporal and geographic density is, since that determination depends on the purpose for which the information is being collected. One approach is to specify the number of times per day and the geographic spread over which measurements should be taken. One of the advantages of crowdsourcing is that, since it is based on when and where people use their phones, by its nature the results will be patterned after consumer demand for service.

Network Impact. The extent to which a measurement programs impacts the networks being measured obviously is a function of the extensiveness of the testing, so it is difficult to speak specifically to this issue. Compared with the vast amounts of traffic carried by the networks today, it is hard to imagine that a measurement program would have even a discernible impact.

Nevertheless, if the Commission is concerned about the network impact, it certainly could assign a premium to testing systems that are able to conduct testing passively, that is, by observing data sent and received by the device user rather than by transmissions that are proactively initiated by the measurement system itself.

VI.   Data Analysis and Reports

Having collected large amounts of data, the next step will be to transform it into actionable information through data analysis. Root Wireless can export data in a variety of file formats, such as Excel, comma separated values, and other commonly used formats.

As evidenced by their widespread usage in the marketing materials used by wireless carriers, one of the most effective means by which information about wireless networks can be

communicated is through maps. Exhibit A to these comments consists of a series of images of the user interface that Root Wireless will soon begin using to display performance information and is provided as one example of a means by which such information can be communicated to consumers and others.

VII.   Use and Benefits of Performance Information.

Wireless service clearly will play a critical role in the delivery of broadband service to America. In some areas of the country, particularly those that are rural, wireless service is likely to be *the* means by which broadband service is provided. In more urban areas, for the foreseeable future it is likely that higher speed data service will be available from landline providers, but mobile wireless networks will be a critical interstitial element in delivering ubiquitous service. Moreover, wireless service is likely to provide the competitive threat in the marketplace that will help incent landline providers to constantly improve their service. Therefore, it clearly will not be possible to address broadband issues without considering wireless networks and doing so will require a firm understanding of the state of the service.

The potential applications for the information gathered in a study will depend on the comprehensiveness of the information that the Commission requests. Obviously this information would be available to the Commission in connection with the wide variety of issues that it addresses involving wireless service. Surveys of coverage in rural areas could, for example, assist interested parties in directing expenditures from the Universal Service Fund. Information also would supplement that being gathered by the National Telecommunications and Information Administration in its National Broadband Mapping program.

The information gathered also can be used to assess, objectively and analytically, a variety of network practices and consumer perceptions. For example, consumer complaints can

be verified. The accuracy of carriers' claims and commitments regarding coverage and performance can be measured. With a deeper level of analysis, it is possible to assess whether traffic is being treated equivalently regardless of the device being used or the source, destination, or type of traffic.

CONCLUSION

Until recently, only the wireless carriers themselves could afford to gather large amounts of information regarding the performance of their networks. Now, however, the tools exist that make it possible for the Commission to obtain comparable information that can then be used to inform the multitude of decisions that arise in the course of overseeing the wireless industry. Root Wireless recommends that the Commission avail itself of these tools and undertake the measurement program that is contemplated in the Notice.

Respectfully submitted,

ROOT WIRELESS, INC.

By _/s/ Mark D. Bradner_

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Root Metrics Coverage Map

Explanatory Notes

- The contents of individual map screens are described on the following page
- The images contained here are for presentation purposes only and do not reflect actual measurements or data
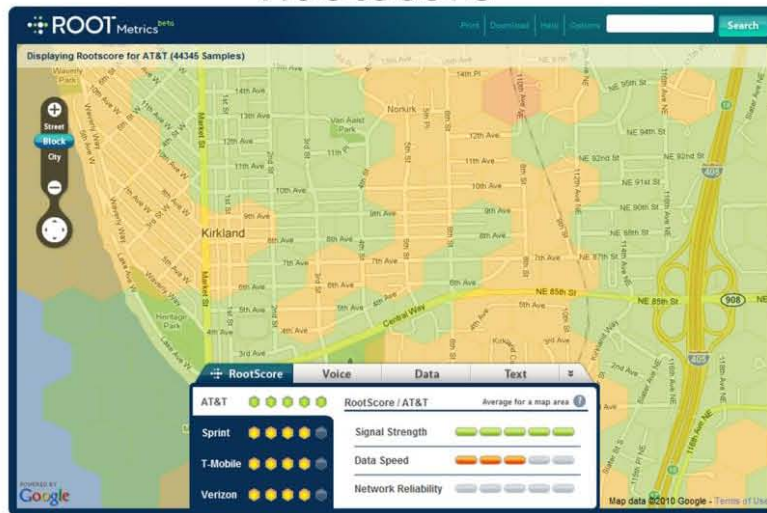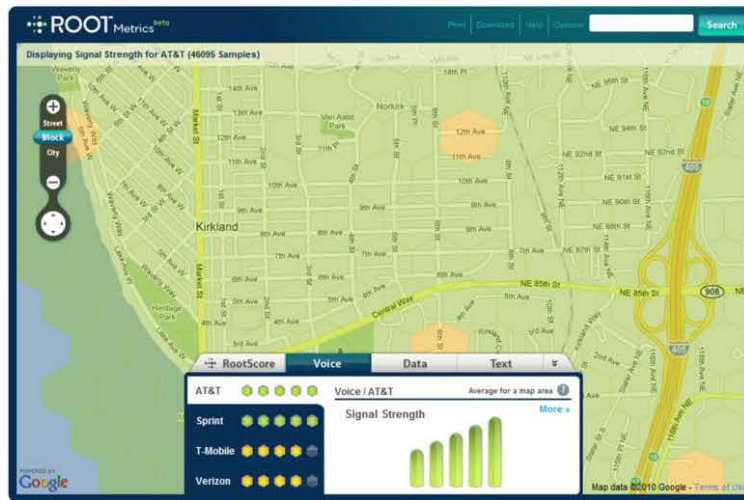
Metrics Details

- RootScore
  - Shows the overall Quality of Service for a particular carrier in the area shown calculated according to a proprietary algorithm
- Voice
  - Voice: Shows the ability for a user with a particular carrier to make and receive phones calls in a given area based on signal strength
  - Voice Details: Average signal strength, in decibels, observed from a particular carrier within the area shown
  - Voice Hex Popup: Average signal strength within the area of a specific hexagon contained in the map
- Data
  - Data: Shows the speed for a user with a particular carrier to upload and download files in a given area
  - Data Details: Average download throughput rate, in kilobits per second, observed from a particular carrier within the area shown
  - Data Hex Popup: Average download and upload rates within the area of a specific hexagon contained in the map
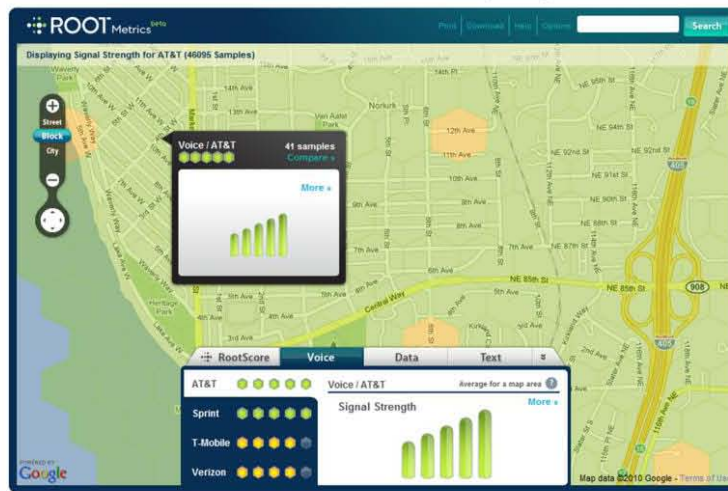
ROOT Metrics
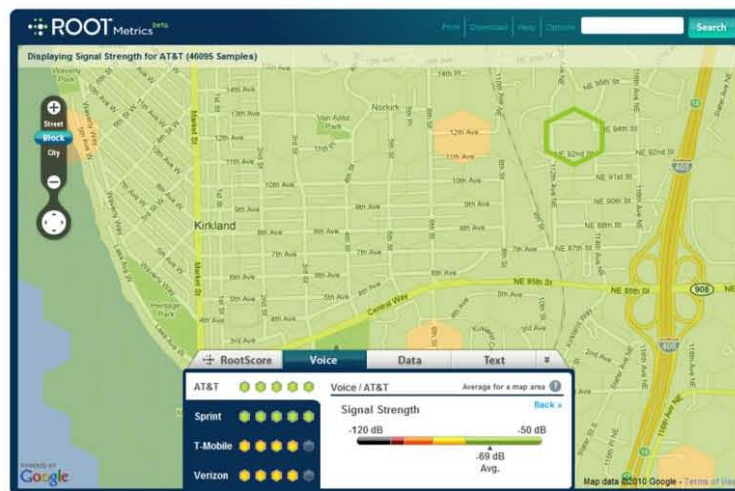
RootScore™

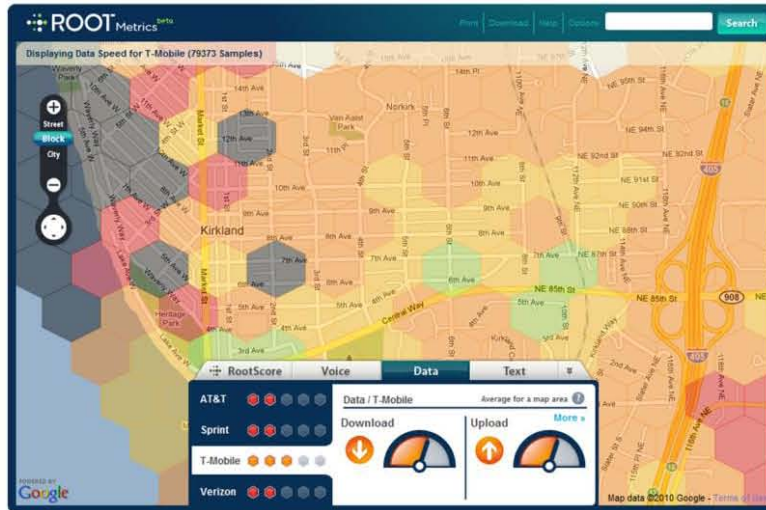ROOT Metrics

Voice

Voice - Details

Voice – Hex Popup

Data

Data - Details

Data – Hex Popup